CLAIMS

1. A method for synchronizing data utilized in a redundant, closed-loop feedback control system, the method comprising:

configuring a plurality of control nodes within the control system, each of said plurality of control nodes transmitting and receiving data through a common communication bus;

at each of said plurality of control nodes, during a given control loop time T = N, verifying the receipt of externally generated data with respect to each control node, said externally generated data having been generated during a preceding control loop time T = N-1; and

at each of said plurality of control nodes, during said given control loop time T = N, calculating output control data using said externally generated data;

wherein, during said given control loop time T = N, said calculated output control data from each individual control node is further transmitted over said communication bus to be later utilized by other control nodes coupled to said communication bus during a subsequent control loop time T = N+1.

2. The method of claim 1, further comprising:

at each of said plurality of control nodes, during said given control loop time T = N, calculating reference input data using said externally generated data received during said preceding control loop time T = N-1.

3. The method of claim 2, further comprising:

at each of said plurality of control nodes, during said given control loop time T = N, acquiring local sensor inputs, said local sensor inputs further being transmitted through said communication bus to be used by other control nodes during said subsequent control loop time T = N+1.

4. The method of claim 3, wherein:

said local sensor inputs acquired at each of said plurality of control nodes during said given control loop time T = N are further used in calculating output control data during said subsequent control loop time T = N+1.

5. The method of claim 4, further comprising:

configuring a plurality of sensing nodes within the control system, each of said plurality of sensing nodes transmitting and receiving data through said common communication bus;

wherein, said externally generated data with respect to each control node includes outputs from said plurality of sensing nodes.

6. The method of claim 5, wherein:

said outputs from said plurality of sensing nodes include feedforward signals.

7. The method of claim 6, wherein:

said local sensor inputs acquired at each of said plurality of control nodes include feedback signals.

8. The method of claim 7, wherein:

said local sensor inputs acquired at each of said plurality of control nodes further include reference input signals.

9. The method of claim 8, wherein:

said feedforward signals include a primary feedforward signal and a secondary feedforward signal;

said feedback signals include a primary feedback signal and a secondary feedback signal;

said reference input signals include a primary reference input signal and a secondary reference input signal; and

during said given control loop time T = N, said plurality of control nodes utilize one of said primary and secondary feedforward signals, one of said primary and secondary feedback signals, and one of said primary and secondary reference input signals.

10. The method of claim 1, further comprising:

during said given control loop time T = N, running an error detection algorithm for each of said plurality of control nodes, said error detection algorithm determining a diagnostic operating status for each of said plurality of control nodes;

wherein, based upon the determined diagnostic operating status for each of said plurality of control nodes, said error detection algorithm further determines an operating configuration of feedforward, feedback and reference input signals for each of said plurality of control nodes.

11. A method for synchronizing data utilized in a redundant, closed-loop feedback control system, the method comprising:

configuring a first control node to control a first actuator, said first actuator producing a first actuator output;

configuring a second control node to control a second actuator, said second actuator producing a second actuator output, said first and second actuator outputs further being combined to control a plant;

configuring a communication bus for transmitting data signals to and from said first and second control nodes;

at both of said first and second control nodes, during a given control loop time T = N, verifying the receipt of externally generated data with respect to each of said first and second control nodes, said externally generated data having been generated during a preceding control loop time T = N-1; and

at both of said first and second control nodes, during said given control loop time T = N, calculating output control data using said externally generated data;

wherein, during said given control loop time T = N, said calculated output control data from said first and second control nodes is further transmitted over said communication bus to be utilized during a subsequent control loop time T = N+1.

12. The method of claim 11, wherein:

at said first control node, said output control data further comprises a first actuator output command; and

at said second control node, said output control data further comprises a second actuator output command.

13. The method of claim 12, further comprising:

configuring a first sensing node to receive a first feedforward sensor input, said first sensing node coupled to said communication bus; and

configuring a second sensing node to receive a second feedforward sensor input, said second sensing node coupled to said communication bus;

wherein said first and said second feedforward sensor inputs are included in said externally generated data with respect to said first and second control nodes.

14. The method of claim 13, further comprising:

at said first control node during said given control loop time T = N, calculating a first reference input from data externally generated with respect to said first control node during said preceding control loop time T = N-1;

at said second control node during said given control loop time T = N, calculating a second reference input from data externally generated with respect to said second control node during said preceding control loop time T = N-1;

wherein said calculated first and second reference inputs during T = N are transmitted over said communication bus, so as to be accessible during said subsequent control loop time T = N+1.

15. The method of claim 14, further comprising:

at said first control node during said given control loop time T = N, acquiring and storing a first feedback sensor input; and

at said second control node during said given control loop time T = N, acquiring and storing a second feedback sensor input;

wherein said acquired and stored first and second reference feedback sensor inputs during T = N are transmitted over said communication bus, so as to be accessible during said subsequent control loop time T = N+1.

16. The method of claim 15, further comprising:

during said given control loop time T = N, running an error detection algorithm for said first and second control nodes and for said first and second sensing nodes, said error detection algorithm determining a diagnostic operating status for each of said first and second control nodes and said first and second sensing nodes;

wherein, based upon the determined diagnostic operating status for each of said first and second control nodes and said first and second sensing nodes, said error detection algorithm further determines an operating configuration of feedforward, feedback and reference input signals for said first and second control nodes during said subsequent control loop time T = N+1.

17. The method of claim 16, wherein during said given control loop time T = N:

said first and said second control nodes use a common reference input signal in producing said first actuator output and said second actuator output, respectively, said common reference input signal being chosen by said error detection algorithm from one of said first input reference signal and said second input reference signal;

said first and said second control nodes further use a common feedforward signal in producing said first actuator output and said second actuator output, respectively, said common feedforward signal being chosen by said error detection algorithm from one of said first feedforward signal and said second feedforward signal; and

said first and said second control nodes further use a common feedback signal in producing said first actuator output and said second actuator output, respectively, said common feedback signal being chosen by said error detection algorithm from one of said first feedback signal and said second feedback signal.

18. The method of claim 17, wherein:

said error detection algorithm may select said common reference input signal independently from said common feedforward signal and said common feedback signal.

19. The method of claim 17, wherein:

said error detection algorithm may select said common feedforward signal independently from said common reference input signal and said common feedback signal.

20. The method of claim 17, wherein:

said error detection algorithm may select said common feedback signal independently from said common feedforward signal and said common reference input signal.

21. A redundant, closed loop feedback control system, comprising:

a first control node coupled to a first actuator, said first actuator producing a first actuator output;

a second control node coupled to a second actuator, said second actuator producing a second actuator output, said first and second actuator outputs further being combined to control a plant;

a communication bus for transmitting data signals to and from said first and second control nodes;

said first control node receiving a primary reference input signal and a primary feedback signal, said primary reference input signal and said primary feedback signal being generated locally with respect to said first control node, said second control node also receiving, through said communication bus, both said primary reference input and said primary feedback signal;

said second control node receiving a secondary reference input signal and a secondary feedback signal, said secondary reference input signal and said secondary feedback signal being generated locally with respect to said second control node, said first control node also receiving, through said communication bus, both said secondary reference input and said secondary feedback signal; and

means for synchronizing, within a given control loop time $T = N$, a selected set of reference input signals and feedback signals to be used in producing said first and second actuator outputs;

wherein said selected set of reference input signals and feedback signals used in producing said first and second actuator outputs are generated during a previous control loop $T = N - 1$.

22. The system of claim 21, further comprising:

a first sensing node for receiving a primary feedforward input, said first sensing node coupled to said communication bus; and

a second sensing node for receiving a secondary feedforward input, said second sensing node coupled to said communication bus;

wherein said first and second control nodes are capable of receiving said primary and secondary feedforward inputs through said communication bus.

23. The system of claim 22, further comprising:

an error detection algorithm, implemented during said given control loop T = N, said error detection algorithm for determining a diagnostic operating status for each of said first and second control nodes and said first and second sensing nodes;

wherein, based upon the determined diagnostic operating status for each of said first and second control nodes and said first and second sensing nodes, said error detection algorithm further determines an operating configuration of feedforward, feedback and reference input signals for said first and second control nodes during said subsequent control loop time T = N+1.

24. The system of claim 23, wherein during said given control loop time T = N:

said first and said second control nodes use a common reference input signal in producing said first actuator output and said second actuator output, respectively, said common reference input signal being chosen by said error detection algorithm from one of said first input reference signal and said second input reference signal;

said first and said second control nodes further use a common feedforward signal in producing said first actuator output and said second actuator output, respectively, said common feedforward signal being chosen by said error detection algorithm from one of said first feedforward signal and said second feedforward signal; and

said first and said second control nodes further use a common feedback signal in producing said first actuator output and said second actuator output, respectively, said common feedback signal being chosen by said error detection algorithm from one of said first feedback signal and said second feedback signal.

25. The system of claim 24, wherein:

said error detection algorithm may select said common reference input signal independently from said common feedforward signal and said common feedback signal.

26. The system of claim 24, wherein:

said error detection algorithm may select said common feedforward signal independently from said common reference input signal and said common feedback signal.

27. The system of claim 24, wherein:

said error detection algorithm may select said common feedback signal independently from said common feedforward signal and said common reference input signal.

28. A storage medium, comprising:

a machine readable computer program code for synchronizing data utilized in a redundant, closed-loop feedback control system; and

instructions for causing a computer to implement a method, the method further comprising:

during a given control loop time T = N, verifying the receipt of externally generated data with respect to each of a plurality of control nodes configured within the control system, said externally generated data having been generated during a preceding control loop time T = N-1; and

at each of said plurality of control nodes, during said given control loop time T = N, calculating output control data using said externally generated data;

wherein, during said given control loop time T = N, said calculated output control data from each individual control node is further transmitted over a common communication bus to be later utilized by other control nodes coupled to said communication bus during a subsequent control loop time T = N+1.

29. The storage medium of claim 28, further comprising:

at each of said plurality of control nodes, during said given control loop time T = N, calculating reference input data using said externally generated data received during said preceding control loop time T = N-1.

30. The storage medium of claim 29, further comprising:

at each of said plurality of control nodes, during said given control loop time T = N, acquiring local sensor inputs, said local sensor inputs further being transmitted through said communication bus to be used by other control nodes during said subsequent control loop time T = N+1.

31. The storage medium of claim 30, wherein:

said local sensor inputs acquired at each of said plurality of control nodes during said given control loop time T = N are further used in calculating output control data during said subsequent control loop time T = N+1.

32. The storage medium of claim 31, further comprising:

configuring a plurality of sensing nodes within the control system, each of said plurality of sensing nodes transmitting and receiving data through said common communication bus;

wherein, said externally generated data with respect to each control node includes outputs from said plurality of sensing nodes.

33. A computer data signal, comprising:

code configured to cause a processor to implement a method for synchronizing data utilized in a redundant, closed-loop feedback control system, the method further comprising:

configuring a plurality of control nodes within the control system, each of said plurality of control nodes transmitting and receiving data through a common communication bus;

at each of said plurality of control nodes, during a given control loop time T = N, verifying the receipt of externally generated data with respect to each control node, said externally generated data having been generated during a preceding control loop time T = N-1; and

at each of said plurality of control nodes, during said given control loop time T = N, calculating output control data using said externally generated data;

wherein, during said given control loop time T = N, said calculated output control data from each individual control node is further transmitted over said communication bus to be later utilized by other control nodes coupled to said communication bus during a subsequent control loop time T = N+1.

34. The computer data signal of claim 33, further comprising:

at each of said plurality of control nodes, during said given control loop time T = N, calculating reference input data using said externally generated data received during said preceding control loop time T = N-1.

35. The computer data signal of claim 34, further comprising:

at each of said plurality of control nodes, during said given control loop time T = N, acquiring local sensor inputs, said local sensor inputs further being transmitted through said communication bus to be used by other control nodes during said subsequent control loop time T = N+1.

36. The computer data signal of claim 35, wherein:

said local sensor inputs acquired at each of said plurality of control nodes during said given control loop time T = N are further used in calculating output control data during said subsequent control loop time T = N+1.

37. The computer data signal of claim 36, further comprising:

configuring a plurality of sensing nodes within the control system, each of said plurality of sensing nodes transmitting and receiving data through said common communication bus;

wherein, said externally generated data with respect to each control node includes outputs from said plurality of sensing nodes.